THE STRUCTURE AND THICKNESS OF THE LUNAR CRUST. Mark A. Wieczorek and Roger J. Phillips; Dept. Earth and Planetary Sciences, Washington Univ., 1 Brookings Dr., Box 1169, St. Louis, MO 63130, markw@wurtzite.wustl.edu.

Introduction: The structure and thickness of the lunar crust is for the most part largely unknown. Seismic measurements have been made, but the most reliable seismic profiles are only valid for the region of the Apollo 12 and 14 landing sites, where discontinuities were found approximately 20 and 60 km below the surface [1]. Whereas the 60 km discontinuity has been interpreted as the lunar Moho, the origin of the 20 km discontinuity is less certain, though is also most likely partly compositional in origin [1,2].

Evidence for a Stratified Crust: Using lunar gravity and topography, many investigators have constructed crustal thickness maps assuming that the gravity anomalies are due exclusively to variations in surface as well as Moho relief, e.g. [3]. If the crust were stratified, however, computed crustal thickness maps would differ substantially in character.

The following lines of evidence suggest to us that the crust is in fact stratified: (i) The existence of a sharp seismic discontinuity 20 km below the Apollo 12 and 14 sites is hard to explain without invoking some form of compositional change, (ii) The composition of a subset of the noritic impact melt rocks, "LKFM", cannot be modeled in terms of known "pristine" highland samples. This suggests that a major crustal component has not yet been sampled, e.g. [4]. (iii) The ejecta blankets of large basins becomes more noritic with increasing basin size, suggesting that larger basins excavate greater amounts of a more mafic lower crustal material [5], and (iv) measured geoid-to-topopgraphy-ratios (GTRs) for the lunar highlands require some form of compositional stratification [2].

Crustal Thickness Models: Assuming that the crust is stratified, we are currently computing global crustal thickness maps that are consistent with the lunar GTRs. Specifically, we are investigating the following end-member scenarios in which: (i) the gravity anomalies are exclusively due to variations in surface relief, as well as relief along an intracrustal interface approximately 30 km below the surface, (ii) the gravity anomalies are due to variations in surface relief, intracrustal relief, and hydrostatic Moho relief, and (iii) the gravity anomalies are due to surface, intracrustal, and Moho relief, where the thickness of the lower crust is constrained to have a constant thickness of approximately 30 km.

In computing these crustal thickness maps, the finite amplitude nature of relief along an interface is taken into account using a spherical analog of Parker's algorithm [6]. Using this method, potential anomalies can be computed to arbitrary precision by expanding the topography raised to the nth power in spherical harmonics.

Implications of a Stratified Crust: Analysis of the above crustal thickness maps address several questions. First of all, which of the above crustal thickness models (if any) are applicable to the Moon? Some of the above models may be able to be discarded entirely if unphysical results are obtained (such as negative crustal thicknesses). Additionally, if one crustal thickness model can be singled out, this would have important implications for the origin of the crust, as well as its thermal history.

Secondly, could lower crustal or mantle material be exposed at the surface, such as beneath South Pole-Aitken (SPA) basin or any of the other large impact basins? Analysis of Clementine spectral reflectance data suggests that the floor of SPA basin may be composed of lower crustal and/or mantle material [7,8]. If it could be shown to reasonable certainty that mantle material was *not* excavated in the SPA impactor event, this result could have dramatic implications for impact cratering studies.

Thirdly, were the basins in isostatic equilibrium before the mare basalts were emplaced? The answer to this question could place constraints on how much heat was deposited in the crust during the impacting event, as well as the thermal history of basin region.

And lastly, the total volume of upper crustal and lower crustal materials are important parameters for modeling the origin of the crust. As an example, the total amount of anorthosite places strict constraints on the depth of a putative “magma ocean.”

Preliminary Results: Crustal thickness maps have been constructed for the scenario in which the observed gravity anomaly is due to relief along the surface as well as relief along an intracrustal interface. Analysis of these crustal thickness maps have many important implications. First, the average crustal thickness in the SPA basin is close to zero. In a few localities within this region the computed crustal thicknesses are unrealistic (i.e. approximately -2 km), though it is important to point out that the farside gravity field is poorly known. Thus, if one believes that the upper crust is compensated entirely at the intracrustal boundary, this implies that lower crustal material should be exposed at the surface within the SPA basin.

One problem with this model, however, is that unrealistic crustal thicknesses (from 0 to -10 km) were obtained beneath many of the nearside basins. Thus, in order to satisfy the lunar gravity field, one must also take into account relief along the Moho in addition to intracrustal relief.

References: [1] Toksöz, M. N. et al., *Rev. Geophys. Space Phy., 12*, 539-567, 1974; [2] Wieczorek M. A., and R. J. Phillips, *submitted to J. Geophys. Res. 1996*; [3] Neumann G., et al., *J. Geophys. Res. 101*, 16,841-16,843, 1996; [4] Ryder G. and J. A. Wood, *Proc. Lunar Sci. Conf. 8th*, 655-668, 1977; [5] Spudis, P., B., et al., *Proc. Lunar Planet. Sci. Conf. 15th, J. Geophys. Res. 89*, C197-C210, 1984; [6] Parker, R. L., *Geophys. J. R. astr. Soc*., 447-455, 1972; [7] Lucey, P. G., et al., *Science 268*, 1150-1153, 1995; [8] Lucey, P. G., et al., *LPSC XXVII (abstract)*, 783-784, 1996.